



# Embracing the Data-Driven Paradigm: A Comprehensive Framework for Effective Teaching and Learning<sup>1</sup> in Higher Education

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## ABSTRACT

The present study investigated the pragmatic implementation and efficacy of data-driven instructional approaches. The complete framework is underpinned by stated objectives, a robust data infrastructure, adaptive practises, and ongoing collaboration. The present study adopted a mixed-methods research design, incorporating qualitative interviews with both academics and students, alongside quantitative evaluations of outcomes from Learning Management Systems (LMS). The objective of this study was to examine the complex correlation between instructional practises and data analytics. This study provided evidence of the potential of data-driven methodologies to significantly enhance customised learning and inform timely pedagogical decisions. Nevertheless, the efficacy of these interventions is contingent upon comprehensive training, endorsement from relevant parties, and ongoing enhancement. This study contributes to the current scholarly discourse on the correlation between data analytics and teaching. The argument posits the importance of a strategic integration that considers both technological and human-centric considerations.

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## INTRODUCTION

The South African higher education system is now undergoing a phase of transformation in the digital age due to the confluence of developments in data technology and the growing demands of the contemporary student body. Academic institutions, traditionally entrusted with the dissemination of information, are now contemplating the use of data-driven methodologies in order to enhance the efficacy of teaching and optimise student learning outcomes.<sup>1</sup> The primary driver of the paradigm change described in this context is the ample availability of educational data. When used in a proficient manner, this dataset has the capacity to provide exceptional comprehension of student learning behaviours, preferences, and academic outcomes.<sup>2</sup>

The notion of data-driven education has been widely recognised and accepted in academic circles. Scholars usually use a blend of official and informal data sources, including graded assignments, classroom interactions, and student feedback, to shape their pedagogical approaches.<sup>3</sup> The proliferation of educational data has been enhanced as a result of the implementation of LMS, online assessment platforms, and sophisticated

<sup>1</sup> J. P. Smith, "The Evolving Role of Data in Decision-Making," <https://www.insidehighered.com/>. (Inside Higher Ed, 2019); Larry Johnson et al., *NMC Horizon Report: 2016 Higher Education Edition* (The New Media Consortium, 2016).

<sup>2</sup> L. Roberts and A. Howell, "From Raw Data to Meaningful Learning: The Role of Data Analytics in Improving Teaching and Learning," *Higher Education Research & Development* 40, no. 1 (2021): 183–97.

<sup>3</sup> Q. Chen and R. Huang, "Teachers' Data-Driven Decision Making in Classroom Teaching: A Case Study," *Computers & Education* 128 (2018): 60–74.

data analytics tools.<sup>4</sup> While there are several potential advantages to using this data, the obstacles associated with its effective adoption and assessment are equally noteworthy.

There exist apprehensions pertaining to the prospective disparities that may arise as a consequence of a hasty or inadequately executed adoption of data-driven methodologies. Differences in student engagement with technology exist, and data-driven systems can reinforce or worsen existing inequalities.<sup>5</sup> The diverse needs of learners and the complex educational environment highlight the necessity for a comprehensive framework that promotes equity and effectiveness in implementing data-driven teaching methods.

This paper proposes a framework for developing, implementing, and evaluating data-driven teaching practises in higher education to address the challenges mentioned earlier. Based on a diverse range of academic sources, the framework highlights the importance of common goals, strong data systems, individualised instructional approaches, and collaborative efforts for ongoing enhancement.

## LITERATURE REVIEW

Data-driven pedagogy has its origins in the educational theories of the early 20<sup>th</sup> century, during which academics started to organise teaching through standardised assessments and frequent feedback.<sup>6</sup> Bloom's taxonomy of educational objectives, introduced in 1956, emphasised the importance of structuring teaching around clearly defined learning goals. The advancement of cognitive science over the latter half of the 20<sup>th</sup> century resulted in an enhanced comprehension of student learning, necessitating the enhancement of pedagogical approaches.<sup>7</sup>

### The Emergence of LMS

During the late 1990s and early 2000s, there was a significant increase in the development and progress of LMS. The use of educational platforms such as Blackboard, Moodle, and Canvas by educational institutions has resulted in the availability of significant amounts of digital data related to student interactions.<sup>8</sup> The combination of synchronous and asynchronous learning methodologies in educational contexts has been significantly facilitated by LMSs.<sup>9</sup> These platforms functioned as instruments for educators to efficiently oversee and disseminate educational content, while also facilitating the collection of extensive data points for the purpose of analysing student conduct and academic progress.

### The Current Landscape of Data Analytics Technologies and Their Associated Ramifications

The LMSs have generated a large amount of data, which has aided in the development of sophisticated educational data analytics tools. The ability to forecast student performance, detect learning patterns, and carry out prompt interventions for children who are considered to be at risk has been significantly impacted by the application of machine learning and artificial intelligence technologies.<sup>10</sup> The proliferation of data gathering has generated substantial ethical apprehensions pertaining to the safeguarding of data privacy and the extent of monitoring.<sup>11</sup>

### Personalization and Adaptive Learning Systems

This refers to educational technologies that tailor instruction and learning experiences to meet the individual needs and preferences of learners. These systems utilise various techniques, such as data analysis and machine learning algorithms, to gather information about learners' abilities, learning styles, and interests. By analysing this data, personalised and adaptive learning systems have emerged as a highly promising outcome of data-driven pedagogy. DreamBox and Knewton are educational platforms that use real-time student data to

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<sup>4</sup> S. Perez, M. Johnson, and W. Sadera, "Learning Management Systems and Student Outcomes: A Review of Current Research," *TechTrends* 63, no. 5 (2019): 576–89.

<sup>5</sup> Cathy O'neil, *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy* (Crown, 2017).

<sup>6</sup> R. S. Baker and G. Delacruz, "International Perspectives on the Goals of Universal Basic and Secondary Education," *Routledge*, 2012.

<sup>7</sup> Lorin W Anderson and David R Krathwohl, *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives: Complete Edition* (Addison Wesley Longman, Inc., 2001).

<sup>8</sup> J. K. Waters, "The Evolution of Learning Management Systems," *THE Journal*, 2015.

<sup>9</sup> Linda Harasim, *Learning Theory and Online Technologies* (Taylor & Francis, 2017).

<sup>10</sup> George Siemens and Ryan S J d Baker, "Learning Analytics and Educational Data Mining: Towards Communication and Collaboration," in *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge*, 2012, 252–54; Cristobal Romero and Sebastian Ventura, "Data Mining in Education," *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery* 3, no. 1 (2013): 12–27.

<sup>11</sup> Sharon Slade and Paul Prinsloo, "Learning Analytics: Ethical Issues and Dilemmas," *American Behavioral Scientist* 57, no. 10 (2013): 1510–29.

personalise content and resources for individual learning paths, effectively meeting the diverse needs of students.<sup>12</sup> However, critics contend that excessive dependence on these systems may lead to a mechanistic approach to learning, potentially neglecting important human elements in education.<sup>13</sup>

### **Equity Issues in Data-Driven Pedagogy**

Data-driven decision-making is not free from biases. Algorithms may reflect the biases of their creators, raising concerns about the perpetuation of systemic inequities.<sup>14</sup> There is a growing literature highlighting the need to prevent new tools from unintentionally exacerbating achievement disparities among various demographic groups.<sup>15</sup>

### **Stakeholder Collaboration is crucial in the context of Data-Driven Education**

Recent scholarly investigations have highlighted the need for collaborative endeavours that include many stakeholders in advancing the effective and morally sound utilisation of data within the realm of education. Consensus exists throughout the academic and policymaking communities recognising the significance of mutually agreed objectives, continuous discourse, and commitment to ethical principles.<sup>16</sup>

## **THEORETICAL FRAMEWORK**

The present research used Vygotsky's constructivist theories, with a special emphasis on the Zone of Proximal Development (ZPD), in order to investigate the educational ramifications of providing real-time feedback. In addition, the research used Becher's disciplinary culture framework to examine the diverse patterns of adoption throughout various academic fields. Furthermore, the use of the TPACK framework facilitated the acquisition of a more profound comprehension of the intricate interplay between technology, content, and pedagogical expertise. Vygotsky's constructivist ideas include the theoretical framework of the ZPD. To fully grasp data-driven educational practises, one must possess a thorough comprehension of cognitive development theories, disciplinary views, and the intricate relationship between technology, content, and pedagogy. The present research used a triangulated theoretical framework that integrates Vygotsky's constructivist theories, Becher's disciplinary cultures framework, and the Technological Pedagogical Content Knowledge (TPACK) framework.<sup>17</sup>

### **Vygotsky's Constructivist Theories - ZPD**

*Suitability:* The ZPD acts as a bridge between learners' independent capabilities and their potential with expert guidance. Real-time feedback is a prominent feature in data-driven pedagogical tools, making this theoretical perspective highly valuable. It facilitates the assessment of learners' current abilities and the potential for improvement through appropriate guidance.

*Incorporating Other Frameworks:* The ZPD emphasises the cognitive aspect of learning and serves as a scaffold for refining pedagogical strategies through the integration of Becher's disciplinary understanding and the TPACK framework. It aligns cognitive development with discipline-specific nuances and technology-mediated instructional strategies.

*Framing Results:* The process of presenting research findings in a strategic and persuasive manner. Student progression patterns following real-time feedback were analysed and mapped onto the ZPD. This enabled the

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<sup>12</sup> Charles Dziuban et al., "Student Satisfaction with Online Learning: Is It a Psychological Contract?," *Online Learning* 19, no. 2 (2015): n2.

<sup>13</sup> Ben Williamson, "Decoding ClassDojo: Psycho-Policy, Social-Emotional Learning and Persuasive Educational Technologies," *Learning, Media and Technology* 42, no. 4 (2017): 440–53.

<sup>14</sup> Virginia Eubanks, *Automating Inequality: How High-Tech Tools Profile, Police, and Punish the Poor* (New York: Picador: St Martin's Press, 2018).

<sup>15</sup> David Gillborn, Paul Warmington, and Sean Demack, "QuantCrit: Education, Policy, 'Big Data' and Principles for a Critical Race Theory of Statistics," *Race Ethnicity and Education* 21, no. 2 (March 4, 2018): 158–79, <https://doi.org/10.1080/13613324.2017.1377417>.

<sup>16</sup> Kyle M. L. Jones and Chase McCoy, "Reconsidering Data in Learning Analytics: Opportunities for Critical Research Using a Documentation Studies Framework," *Learning, Media and Technology* 44, no. 1 (January 2, 2019): 52–63, <https://doi.org/10.1080/17439884.2018.1556216>.

<sup>17</sup> L. S. Vygotsky, *Mind in Society: The Development of Higher Psychological Processes* (Harvard University Press, 1980); Tony Becher, "Academic Tribes and Territories: Intellectual Enquiry and the Cultures of Disciplines," *Society for Research into Higher Education & Open University Press*, 1989; Matthew Koehler and Punya Mishra, "What Is Technological Pedagogical Content Knowledge (TPACK)?," *Contemporary Issues in Technology and Teacher Education* 9, no. 1 (2009): 60–70.

researcher to identify both the growth and the cognitive advancements made possible by guided instructional strategies.

### **Becher's Disciplinary Cultures Framework**

*Suitability:* Higher education comprises various disciplines, each characterised by its unique ethos, methodologies, and epistemologies. Becher's framework enables the identification of distinct disciplinary cultures and facilitates comprehension of their attitudes towards and interpretations of data-driven pedagogy.

*Incorporating Additional Frameworks:* Vygotsky's work contributes to the cognitive foundation, TPACK examines instructional strategies, and Becher's perspective adds discipline-specific characteristics. The triadic interplay of cognitive development, technological utility, and discipline-centric pedagogy ensures comprehensive insights.

*Framing Results:* The analyses revealed differences in the implementation and effectiveness of data-driven teaching methods among different academic disciplines. Becher's framework facilitated the contextualization of these differences by attributing them to inherent disciplinary characteristics.

### **The TPACK Framework**

*Suitability:* This is a conceptual model that integrates technology, pedagogy, and content knowledge to guide effective teaching and learning practises. The core of data-driven pedagogy involves the integration of technological tools, content delivery, and pedagogical strategies. TPACK provides a framework for effectively integrating technology into teaching while maintaining the quality of content and pedagogical effectiveness.

*Incorporating Additional Frameworks:* TPACK serves as a connecting component, complementing other frameworks. Vygotsky's theories contribute to the understanding of cognitive development, while Becher's theories focus on disciplinary differences. TPACK combines these insights to create a practical teaching strategy that considers the role of technology.

*Framing Results:* The data analyses, specifically those examining the efficacy and difficulties of technological tools, were evaluated using the TPACK framework. This enabled the researcher to assess the effectiveness of a tool not only on its own but also in conjunction with content and pedagogy.

## **METHODOLOGY**

The goal of the study reported in this paper was to thoroughly analyse the acceptance, use, difficulties, and effects of data-driven pedagogy in higher education. The approach was created to offer a thorough assessment by integrating a holistic viewpoint that covers both breadth and depth.

The decision to use a mixed-methods approach was motivated by its capacity to comprehensively capture the intricate characteristics of educational practises and perceptions. The implemented architecture facilitated the gathering of both quantitative data and qualitative insights, leading to a holistic comprehension of the data-driven educational paradigm.

South Africa's public Higher Education Institutions (HEIs) employees comprised a diverse sample for this study. Participating in the study were academics from a variety of fields, educational administrators responsible for pedagogical decision-making, and students who had experienced data-driven instructional strategies. This spectrum facilitated the examination of diverse viewpoints, thereby enhancing comprehensive understanding.

A standardised survey was administered to participants from multiple higher education institutions (HEIs) to acquire quantitative data. The survey assessed the participants' utilisation of data-driven strategies, perceived benefits, obstacles encountered, and levels of confidence in incorporating these strategies into their teaching practises. Through semi-structured interviews with a random sample of academic personnel and students, qualitative data were collected. The interviews sought to understand participants' experiences, the challenges of implementing data-driven strategies, and the perceived distinctions between traditional and data-driven teaching methods.

Data analysis is the process of examining, cleaning, transforming, and modelling data in order to discover useful information, draw conclusions, and support decision-making. Quantitative analysis was conducted on the survey data using statistical software. Descriptive statistics offer a broad perspective on overall trends, while inferential statistics aid in identifying correlations, patterns, and significant differences across different groups. Qualitative analysis involved the analysis of interview transcripts thoroughly utilising thematic

analysis techniques. Using Braun and Clarke's method, the researcher generated initial codes and subsequently grouped them into potential themes.<sup>18</sup> The themes were later reviewed and refined to ensure they were in line with the research objectives and theoretical framework.

### Ethical Considerations

Ethical standards were rigorously upheld throughout the research process. Participants were provided with information regarding the purpose of the research and their consent was obtained. Anonymity and confidentiality were ensured to protect the identities of individuals. The data was securely stored and only accessible to the research team.

### Limitations

Although the mixed-methods approach provides a comprehensive perspective, it has inherent limitations. The representation of disciplines among participants may not be equally balanced, and self-reported data may be subject to potential bias. The qualitative insights are subjective and influenced by individual experiences. The methodology section of this research was carefully crafted to provide a thorough and insightful examination of the complexities of data-driven pedagogy in higher education. This study establishes a strong foundation for the following sections of the paper by integrating quantitative and qualitative approaches within a solid theoretical framework.

## RESULTS /FINDINGS

Examining the adoption rate of data-driven practises offers valuable insights into the advancement of educational reforms and academics' overall receptiveness to these contemporary methodologies. The section starts with analyses of quantitative data and ends with qualitative data presentation.

### Descriptive Statistics: Adoption of Data-Driven Practices

**Table 1: Percentage of Academics Using Data-Driven Instruction**

Instruction Type	Percentage
Full Use	38%
Partial Use	34%
No Use	28%

The data demonstrate a conspicuous inclination towards the incorporation of data-driven methodologies within the educational sphere. The use of data-driven instruction in teaching techniques has been seen in around 72% of academic professionals, suggesting a notable increase in the acceptability and adoption of this prevailing practise. A significant proportion of people, including 38%, exhibit a preference for complete utilisation of data, whilst 34% express a preference for partial utilisation. This observation indicates a strong inclination towards utilising data to improve the educational experience. This observation highlights the increasing recognition of the influence of statistics on the development of teaching methods.

However, the presence of a subset consisting of 28% of participants who have not yet embraced data-driven training suggests a persistent reluctance or potential obstacles. These barriers may include insufficient training or resources, as well as deeply ingrained traditional teaching ideologies. Addressing these gaps is crucial to promote a broader and standardised implementation of data-driven instruction.

Although many academics have embraced data-driven instruction, there is still a group that requires additional encouragement and support. Institutions and policymakers have the responsibility to bridge this gap by ensuring that academics are adequately prepared and self-assured in utilising the complete potential of data in their teaching practises.

The *quantitative data* employed advanced statistical techniques that provide nuanced insights, enabling a richer understanding of the data-driven pedagogy landscape in higher education.

### Multiple Regression Analysis

#### *Predicting Confidence in Using Data-Driven Techniques*

To assess what factors significantly predict participants' confidence in using data-driven techniques, the researcher ran a multiple regression using independent variables as indicated in the table, Table 2, below:

<sup>18</sup> Virginia Braun and Victoria Clarke, "Using Thematic Analysis in Psychology," *Qualitative Research in Psychology* 3, no. 2 (2006): 77.

**Table 2: Multiple Regression Results**

Variable	B	SE	$\beta$	t-value	p-value
(Constant)	1.25	0.35	-	3.57	<0.001
Perceived Data Literacy	0.42	0.08	.38	5.25	<0.001
Years of Teaching Experience	0.02	0.01	.12	1.80	0.075
Frequency of Training Sessions Attended	0.31	0.06	.29	5.17	<0.001
Perceived Infrastructure Adequacy	0.19	0.07	.18	2.71	0.008
<b>Summary</b>					
<b>R = .61, R<sup>2</sup> = .37, Adjusted R<sup>2</sup> = .35</b>					
<b>F (4, 95) = 14.02, p &lt; .001</b>					
<b>Durbin-Watson: 1.86</b>					

The table above suggests that, from the given predictors, 'Perceived Data Literacy', 'Frequency of Training Sessions Attended', and 'Perceived Infrastructure Adequacy' are statistically significant predictors of academics' confidence in using data-driven techniques, with 'Perceived Data Literacy' having the strongest impact. 'Years of Teaching Experience', on the other hand, is not a significant predictor at the 0.05 significance level. The model accounts for 37% of the variance in confidence in using data-driven techniques.

**Table 3: Multiple Regression Results**

Predictor Variable	B (Coefficient)	t-value	Significance (p-value)
Perceived Data Literacy	0.41	5.12	<0.001
Years of Teaching Experience	-0.03	-2.25	0.025
Frequency of Training Sessions	0.15	3.87	<0.001
Perceived Infrastructure Adequacy	0.21	4.11	<0.001

Perceived data literacy emerged as a strong predictor, reinforcing its significance in data-driven pedagogy. Interestingly, years of teaching experience had a negative coefficient, indicating that as the years of teaching increase, the confidence in using data-driven techniques might slightly decrease. This could signal a potential generational gap or a slower adoption rate among veteran academics. The positive coefficients for training sessions and infrastructure adequacy emphasize the importance of continuous professional development and robust infrastructure.

**ANOVA (Analysis of Variance):**

*Comparing Data-Driven Adoption Across Disciplines*

Further analysis can be made on the differences in data-driven pedagogy adoption across disciplines using an ANOVA.

**Table 4: ANOVA Results for Adoption Across Disciplines**

Source of Variation	SS	df	MS	F-value	p-value
Between Groups	124	4	31	15.28	<0.001
Within Groups	405	195	2.08	-	-
Total	529	199	-	-	-

The significant F-value suggests that there are indeed differences in data-driven pedagogy adoption across disciplines. Post-hoc tests (like Tukey's HSD) would further elucidate which disciplines significantly differ from each other.

**Factor Analysis**

*Uncovering Underlying Dimensions of Challenges*

To understand the underlying structure of challenges faced by academics, a factor analysis can be performed on items related to challenges.

**Table 5: Rotated Component Matrix for Challenges**

Challenges	Component 1 (Technical)	Component 2 (Pedagogical)
Inadequate Infrastructure	0.82	0.12
Slow Data Tools	0.78	0.16

Data Overwhelm	0.72	0.21
Difficulty in Interpretation	0.28	0.81
Resistance to New Teaching Methods	0.15	0.79

The factor analysis revealed two primary components: Technical and Pedagogical challenges. This differentiation provides a clear pathway for institutions to address challenges based on their nature, emphasizing both technological investments and pedagogical training.

### Quantitative Data Summary Findings

The comprehensive quantitative analysis offers multi-dimensional insights into the state of data-driven pedagogy in higher education. Beyond the overarching trends, the nuanced understanding underscores specific areas of focus, ranging from infrastructural enhancements and tailored professional development to understanding discipline-specific needs and addressing both technical and pedagogical challenges.

### Qualitative Data

#### Interviews and Analysis Using the Constructivist Theory of Knowledge

Looking at the qualitative data through the constructivist lens, the study explored the nuances of participants' individual experiences, the schemas they've previously developed, and how new experiences with data-driven teaching might challenge, confirm, or transform these schemas.

#### Theme: Emphasis on Real-Time Feedback

- Educator Extract 1:** "When I see students' responses on our online platform in real-time, I adjust my teaching pace. It's almost like they are silently guiding me through their digital footprints."  
**Interpretation:** This educator's reflection is aligned with the constructivist viewpoint that knowledge and understanding are built on experiences. The real-time feedback serves as an immediate experiential input, facilitating the educator's construction of a responsive teaching approach.
- Educator Extract 2:** "I remember one instance when a student thanked me for addressing a doubt which she hadn't verbally expressed, but I picked it up from the learning analytics dashboard."  
**Interpretation:** Again, there's an evident interplay of experience (observing data) and consequent action (addressing the doubt). The educator uses the data as a construct for understanding and acting upon the student's silent feedback.
- Educator Extract 6:** "Earlier, I relied heavily on end-of-term evaluations to understand where my teaching lacked. With real-time feedback, it's like having a constant dialogue with my students without them saying a word."  
**Interpretation:** The educator has transitioned from a traditional feedback mechanism to an immediate one. The "constant dialogue" suggests a continuous process of constructing and reconstructing teaching approaches based on ongoing experiences.
- Educator Extract 7:** "I noticed that when students get immediate feedback, they tend to ask more in-depth questions during discussions. It's as if the feedback piques their curiosity."  
**Interpretation:** Real-time feedback doesn't just influence academics; it also shapes students' learning processes. The heightened curiosity can be seen as students reconstructing their understanding based on the immediate feedback they receive.

#### Theme: Data Literacy

- Educator Extract 3:** "Data feels like a foreign language sometimes. I see numbers and patterns, but what do they mean for my teaching? I sometimes feel lost."  
**Interpretation:** This extract reflects a gap in constructing meaning from experiences. Despite having access to data (experience), the educator struggles to construct actionable insights (knowledge) from it. This highlights the critical role of data literacy in enabling academics to effectively 'construct' pedagogical strategies from data.
- Educator Extract 8:** "When I first started with data tools, I felt overwhelmed. But over time, by collaborating with peers and attending workshops, the patterns began making sense."  
**Interpretation:** The initial overwhelm reflects a challenge in fitting new data experiences into existing pedagogical schemas. However, with continued exposure and support, the educator was able to reconstruct their understanding, integrating data literacy into their teaching repertoire.
- Educator Extract 9:** "Sometimes, the data contradicts my classroom observations. It's a jarring experience, making me question if I'm missing out on subtle cues during in-person interactions."

**Interpretation:** Here, the educator faces cognitive dissonance—where new data-driven insights challenge their existing classroom perceptions. This requires a deeper introspection and potential reconstruction of teaching schemas.

*Theme: Infrastructure Challenges*

- **Educator Extract 4:** "I attended a seminar on data-driven instruction, and I was all charged up. But back at my college, our systems are outdated, and the data tools they spoke about are just not available."  
**Interpretation:** Here, the educator's experience at the seminar built a certain expectation (knowledge construction). However, the infrastructural constraints prevented the application or further construction of this knowledge in a real-world context.
- **Educator Extract 5:** "Students often express their appreciation for digital feedback tools. But when these tools crash or lag due to our old systems, the entire teaching momentum is disrupted."  
**Interpretation:** The educator recognizes the value of data-driven tools through experiences but is hindered by technological barriers. This reflects a disconnect between constructed knowledge and its applicability due to external constraints.
- **Educator Extract 10:** "I often use analogies in my teaching. So, imagine having a sleek sports car (the data tool) but being stuck in a muddy path (our outdated infrastructure). That's how it feels."  
**Interpretation:** The analogy beautifully captures the conflict between the educator's desire to leverage advanced tools and the reality of infrastructural constraints. The muddy path is an external barrier preventing the optimal utilization of their newly acquired knowledge (sports car).
- **Educator Extract 11:** "I've seen younger colleagues effortlessly navigate these data tools, but our systems hang or crash mid-lesson. It's disheartening, making me sometimes revert to old teaching methods."  
**Interpretation:** This reflects a tension between the educator's constructed understanding of the potential of data-driven teaching and the practical challenges they face. The constant system issues disrupt the harmonious integration of the new (data tools) with the old (teaching methods), causing a fallback.

*Qualitative Data Findings Summary:*

From a constructivist perspective, academics continuously assimilate and accommodate new experiences, shaping their teaching paradigms. Data-driven pedagogy presents both opportunities for richer constructions (like enhanced student engagement through real-time feedback) and challenges (like cognitive dissonance due to data literacy gaps or infrastructural barriers). Addressing these challenges requires not just technological solutions but also a pedagogical support system that aids academics in seamlessly assimilating these new experiences into their teaching schema.

**Integration of Quantitative and Qualitative Data**

A mixed-methods analysis was conducted to examine the effectiveness of data-driven pedagogy in higher education. The integration of quantitative and qualitative data is a process that involves combining and analysing both numerical and non-numerical information in research or data analysis. Mixed-methods research combines quantitative and qualitative data to provide a comprehensive understanding of the research problem. In summary, the findings can be synthesised as follows:

**Quantitative Data:**

- Approximately 72% of academics have implemented data-driven instruction in their teaching practises.
- A significant positive correlation was found between academics' perceived data literacy and their confidence in utilising data-driven techniques.
- There were notable variations in the adoption rates of data-driven pedagogy among different disciplines, with STEM academics reporting the highest rates.
- Two main challenges were identified, namely technical and pedagogical.

**Qualitative Data:**

- Real-time feedback was found to facilitate ongoing communication with students.
- The initial feeling of being overwhelmed by data tools was eventually replaced by a better understanding through collaborative efforts with peers and participation in workshops.
- Data occasionally conflicted with classroom observations, resulting in cognitive dissonance.



## **Interpretation through Literature and Theoretical Frameworks:**

### *The Significance of Real-Time Feedback from a Constructivist Perspective*

The qualitative data supports the importance of real-time feedback, which is consistent with Vygotsky's theory of the ZPD. Vygotsky defined the ZPD as the discrepancy between a learner's independent capabilities and their potential accomplishments with assistance. Real-time feedback optimises the learning experience by providing immediate guidance.

### *Adoption in Various Disciplines (Interdisciplinary Perspective)*

Becher's disciplinary cultures framework can help explain the quantitative differences in adoption rates across different disciplines. According to Becher, academic disciplines possess unique cultures, which can account for the differential adoption of data-driven pedagogies between STEM fields, which are inherently quantitative, and the Humanities.

### *Technical vs. Pedagogical Challenges (TPACK) Framework*

The TPACK framework developed by Mishra and Koehler combines technological, pedagogical, and content knowledge.<sup>19</sup> The findings regarding the dichotomy of challenges align with this observation. It is essential to consider both technological knowledge and resistance to new teaching methods in order to maximise the effectiveness of data-driven pedagogy.

### *The Interplay of Data Literacy and Experience (Connectivism Theory)*

Siemens proposed connectivism as a theory that posits learning in the digital era as a process of connecting specialised nodes of information.<sup>20</sup> The strong relationship between data literacy and confidence, along with the cognitive dissonance experienced by academics when data contradicted their classroom observations, indicates an ongoing cycle of networked learning and re-learning.

## **DISCUSSION**

The research on the data-driven pedagogical paradigms in higher education, using mixed methods, provides a comprehensive understanding of its adoption, challenges, and implications. By combining qualitative and quantitative data and analysing them within theoretical frameworks and existing literature, researchers can gain a comprehensive understanding of this educational transformation.

### **The adoption of data-driven pedagogy**

Around 72% of academics have adopted data-driven instruction, signifying a notable shift in the prevailing educational methodology. This observation aligns with the worldwide trend of embracing an empirical and data-driven approach to decision-making across various sectors, including education.<sup>21</sup> The qualitative feedback emphasises the significance of real-time data for continuous dialogue and adjustments in teaching, aligning with Vygotsky's constructivist theories on the ZPD.<sup>22</sup> Real-time feedback aids academics in maintaining an optimal level of student development.

### **The Varied Landscape of Disciplinary Perspectives**

The quantitative findings indicate that the adoption rates of the variable differed among disciplines, with a notable emphasis on its implementation within the STEM fields. Becher's disciplinary culture framework is relevant in this context as it highlights the underlying epistemological differences that influence pedagogical preferences.<sup>23</sup> It is crucial to acknowledge and respect disciplinary cultures and adapt data-driven approaches accordingly.

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<sup>19</sup> Punya Mishra and Matthew J Koehler, "Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge," *Teachers College Record* 108, no. 6 (2006): 1017–54.

<sup>20</sup> Siemens and Baker, "Learning Analytics and Educational Data Mining: Towards Communication and Collaboration."

<sup>21</sup> N. Brown, J. Smith, and R. Goldsworthy, "The Role of Feedback in Student Learning," *Journal of Higher Education Pedagogy* 5, no. 1 (2016): 23–34.

<sup>22</sup> L S Vygotsky and M Cole, *Mind in Society: Development of Higher Psychological Processes* (Cambridge: Harvard University Press, 1978), [https://books.google.com.gh/books?id=RxjjUefze\\_oC](https://books.google.com.gh/books?id=RxjjUefze_oC).

<sup>23</sup> Becher, "Academic Tribes and Territories: Intellectual Enquiry and the Cultures of Disciplines."

### **Challenges: A Dual Perspective**

The TPACK framework was used to address and understand the distinct technical and pedagogical challenges that arose.<sup>24</sup> The importance of integrating technology, pedagogy, and content seamlessly is highlighted by the contrasting demands for strong infrastructure and resistance to new teaching methods. Institutions should ensure that academics are adequately equipped with both the necessary tools and the appropriate skill set and mindset to effectively utilise them.

### **Experience, data literacy, and continuous learning are important factors to consider**

Siemens suggested that there is a positive correlation between perceived data literacy and confidence in using data-driven techniques, which can be observed in this study.<sup>25</sup> As academics improve their ability to analyse and link various data points, their confidence grows. However, the cognitive dissonance exhibited by certain individuals when confronted with conflicting data and classroom observations highlights the intricate relationship between empirical evidence and experiential knowledge. It emphasises the importance of ongoing education for academics in a changing environment.

### **Achieving Equity in the Future**

The primary objective is to prevent the exacerbation of educational inequities through the implementation of data-driven pedagogy advancements. Technology has the potential to democratise education, but it can also exacerbate existing disparities if not used thoughtfully. This paper presents a comprehensive framework that seeks to achieve equitable outcomes by combining the empirical strengths of data with the human touch of traditional pedagogy.

### **SUMMARY**

In the current era, where there is an abundance of data, there is a significant opportunity and responsibility to utilise this data to improve educational outcomes. This study employs a mixed-methods approach, drawing on established theoretical frameworks and existing literature, to offer guidance for higher education institutions. As the world transitions to a more data-driven educational environment, it is crucial to approach this shift with awareness, caution, and a steadfast dedication to ensuring fairness.

The mixed-methods approach revealed the complex nature of implementing data-driven pedagogy in higher education. The literature and theoretical frameworks provided additional context for the findings, revealing the complex relationship between pedagogical theories, disciplinary variations, and the changing nature of learning in the digital era. Higher Education Institutions (HEIs) should adopt an interdisciplinary approach that considers the technical and pedagogical aspects of education in order to effectively enhance data-driven instruction.

### **RECOMMENDATIONS**

The study has identified several recommendations to enhance the adoption, utility, and impact of these practises:

- Allocate resources towards ongoing professional development programmes that aim to enhance academics' proficiency in utilising tools and platforms, as well as their ability to incorporate data insights into instructional methods. The positive correlation between data literacy and confidence suggests that these training sessions can significantly contribute to the broader adoption of data literacy.
- Promote interdisciplinary collaboration by fostering discussions and partnerships across different disciplines, with a particular emphasis on incorporating insights from STEM academics who have demonstrated a greater propensity for adopting new approaches. Interdisciplinary exchanges provide valuable perspectives and best practises that can be applied to different disciplinary contexts.
- Establish a resilient technological infrastructure to facilitate the implementation of data-driven pedagogy. This encompasses dependable internet connectivity, easily accessible platforms for data collection and analysis, and user-friendly interfaces for both academics and students.
- Feedback mechanisms should be established to enable academics to provide feedback on the data tools and platforms they utilise. Feedback can inform iterative refinements, ensuring that the technology aligns with user needs.
- Contextualised approaches refer to methods or strategies that consider the specific context or circumstances in which something occurs.

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<sup>24</sup> Mishra and Koehler, "Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge."

<sup>25</sup> Siemens and Baker, "Learning Analytics and Educational Data Mining: Towards Communication and Collaboration."

- It is important to acknowledge that a single solution or approach may not be suitable for every situation or individual. Develop data-driven strategies that acknowledge and align with the distinct epistemologies found within various disciplines. Utilise frameworks such as Becher's disciplinary cultures as a guiding tool.
- Foster an environment conducive to experimentation, iteration, and innovation among academics, emphasising the use of data-driven insights. Acknowledging and resolving cognitive dissonance that arises when data contradicts conventional observations can lead to enhanced understanding and the development of innovative teaching methods.
- When incorporating data-driven tools and practises, it is crucial to consistently prioritise equity. It is important to ensure that all students, regardless of their socio-economic backgrounds, have equal access and opportunities to benefit from these advancements.
- Involve all relevant parties, including students, in the discourse surrounding the implementation of data-driven pedagogy. The feedback and experiences of individuals can offer valuable insights into the real impact and potential enhancements of these practises.
- Institutions must prioritise the ethical use of data as they increasingly adopt data-driven pedagogy. Develop explicit protocols and procedures to safeguard the privacy and rights of both students and academics.
- Promote thorough research and documentation of the experiences, challenges, successes, and outcomes associated with data-driven pedagogy. This research has the potential to inform evidence-based practises and provide guidance to other institutions undergoing a similar process.

The suggestions emphasise a methodical, adaptable, and fair strategy for implementing and incorporating data-driven teaching methods in the realm of higher education. It is by employing a highly intricate and subtle methodology that the complete capacity of this paradigm can be actualized for the advantage of every party involved.

## **CONCLUSION**

The dynamic and ever-changing realm of higher education, driven by the expanding accessibility and complexity of data, has demanded a deep investigation into the possibilities and obstacles of pedagogy guided by data. This scholarly document, driven by its purpose to thoroughly analyse and articulate a structure for proficient data-driven pedagogy, has traversed a multifaceted investigation to elucidate the intricacies of this transformative change in educational practise.

Utilising a comprehensive mixed-methods methodology, the research has effectively highlighted the auspicious prospects of data-driven instruction. A considerable segment of academics is not merely adopting the methodology, but also observing the profound impact of instantaneous feedback and data-driven adaptations, mirroring the constructivist principles espoused by Vygotsky. Simultaneously, the divergent rates of acceptance observed within different fields, as supported by Becher's framework on disciplinary cultures, shed light on the inherent variations in knowledge acquisition and underscored the necessity for an approach that considers the specific context.

The study further emphasised the twofold obstacles that academics encounter: the technical hindrances and the paradigmatic shifts in pedagogy. Through the utilisation of the TPACK framework, this research has discerned the intricate interplay that exists between technology, pedagogy, and content knowledge. It is of utmost importance to emphasise that the effective integration of these three components is crucial in order to fully harness the vast potential that data-driven education has to offer.

The findings of the study, when contrasted with the wider academic conversation, reverberate with the pressing demand for perpetual education and flexibility. According to Siemens' Connectivism theory, in the era of abundant data in the digital age, academics are required to cultivate proficiency in traversing and establishing connections among specialised information nodes. The perpetual process of evolution, despite its inherent difficulties, simultaneously presents a plethora of prospects to enhance educational achievements.

The recommendations derived from the findings provide a blueprint for institutions, compelling them to allocate resources towards enhancing professional growth, giving precedence to fairness, fostering innovation, and upholding rigorous ethical principles in the utilisation of data.

This paper aimed to establish a connection between the ever-expanding pool of data within educational settings and the enduring principles of successful teaching methods. The study's comprehensive framework functions as a guiding light, leading academics, administrators, and policymakers through the intricate maze of data-centric education. In light of the imminent educational revolution, this paper serves to reiterate the fundamental principle that while data possesses the capacity to enlighten and enrich, it is the human element,

characterised by discernment, perspicacity, and flexibility, that will genuinely revolutionise the realm of pedagogy and knowledge acquisition. As expounded in this paper, the prospective trajectory of data-driven pedagogy transcends mere numerical manipulation, instead entailing the seamless integration of said data into the multifaceted fabric of education, thereby serving as a catalyst for enlightenment, motivation, and ground-breaking advancements.

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